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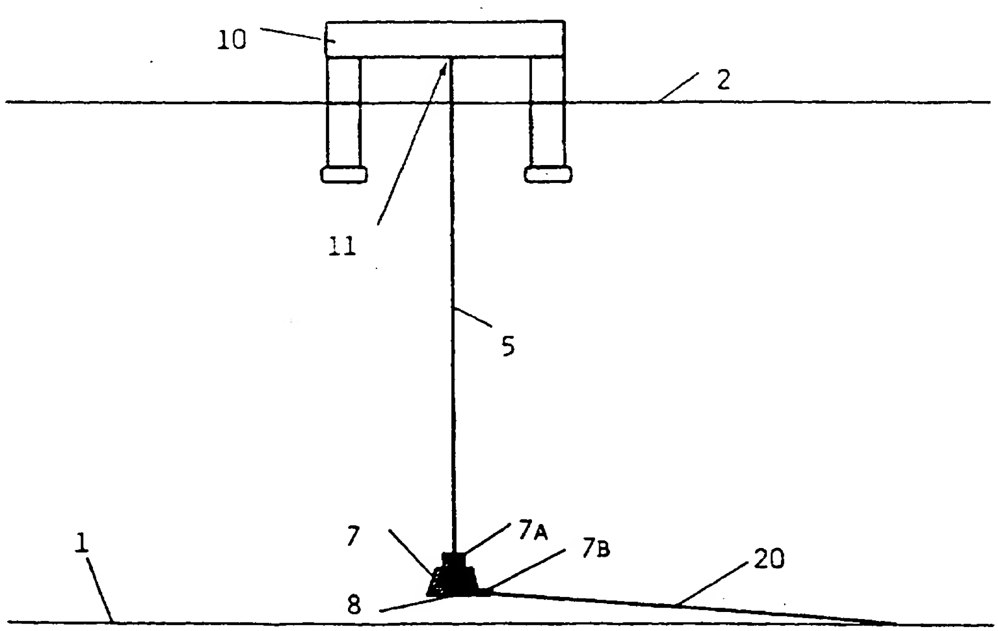
(54) Title: RISER SYSTEM




(57) Abstract

Riser system for connecting a floating surface installation (10) to a pipeline (20) at the seabed (1), comprising a relatively rigid and generally vertical riser (5), the lower end of which during operation is adapted to be located normally at a distance above the seabed (1). A connecting unit is in the first place rigidly connected (7A) to the lower end of the riser (5) and in the second place rigidly connected (7B) to the end of the pipeline (20). The angle between the first and the second rigid connection (7A/7B) to the connecting unit (7) is substantially equal to 90°.

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RISER SYSTEM

This invention relates to a riser system for connecting a floating surface installation to a pipeline on the seabed. For production vessels and floating production platforms intended for operation under harsh weather conditions, the necessary risers represent rather critical elements in the system. Here there may be a question of risers for production or injection in connection with wells at the seabed. The fact that such risers are critical elements are primarily due to wave-induced movements to which the surface installation is subjected. At a typical water depth of e.g. 500 m these movements can be of an order of magnitude ± 50 m vertically and ± 50 m horisontally. At the greater water depth the excursions can be still larger, in particular the horisontal movements.

Traditionally three methods have been used in attempting to obtain control of the wave-induced movements, namely the following:

a) There are employed pre-stressed vertical risers of steel with a heave compensator at the suspension point on the surface installation. A practical limitation in this method is represented by the maximum stroke of the heave compensator.

b) There are employed flexible risers arranged in a suitabel manner by means of buoyancy elements. The flexible risers employed here are expensive and have practical limitations related to pressures and temperatures occuring. At the present time there are also efforts made in introducing titanium tubes as an alternative to these flexible pipe structures, e.g. the so-called Coflexip tubes.

c) For platforms having small movements, i.e. being installed in offshore regions having favourable climatic conditions, there are employed steel risers hanging in a J-configuration.

More particularly reference is also made to Norwegian patents Nos. 152.599 and 153.801, as well as Norwegian patent application No. 84.1281 and besides British patent

publication 2.206.144. The latter patent publication corresponds substantially to the known method according to item b) above. The two Norwegian patents describe solutions with bridge-like frames running at a slope downwards between the lower end of risers and pipeline terminations at the seabed, including in part rotateable connections or joints for attending to the wave-induced movements mentioned above. These known solutions lead to rather complicated and cumbersome structures, being both expensive and subject to operational disturbances.

The invention is directed to a simpler and more inexpensive solution representing significant advantages compared to the prior art discussed above. This is obtained by a combination of novel and specific features consisting in the first place in a relatively rigid and generally vertical riser, the lower end of which during operation is adapted to be normally located at a distance above the seabed, and a connecting unit being at one hand rigidly connected to the lower end of the riser and being at the other hand rigidly connected to the end of the pipeline, the angle between the first and the second rigid connection to the connecting unit, being substantially equal to 90°.

A main point in this solution is that the riser elements themselves, i.e. the riser and the seabed pipeline respectively, by elastic deformation contribute to making possible the intended freedom of movement, as will be more closely explained in the following description. The connecting unit for the junction or interconnection between the ends of the riser and the pipeline, constitutes a very compact and simple structure without any mutually moveable parts.

In the following description with reference to the drawings, the invention as well as further particular features and advantages thereof, will be explained more closely in relation to exemplary embodiments.

The drawings show:

Fig. 1 a schematic and simplified elevation view of an embodiment of the riser system according to the

invention,

Fig. 2 a highly schematic illustration of changes in the riser configuration due to wave-induced movements,

Fig. 3 a vertical section and more in detail a possible embodiment of the actual connecting unit, and

Fig. 4 in schematic elevation view an embodiment having several risers and several connecting units arranged in a form of common frame.

Fig. 1 shows a surface installation or platform 10 floating at the sea surface 2 with a certain water depth above the seabed 1. From a suspension point 11 at the platform 10 there is suspended a vertical riser 5 being connected to the end of a pipeline 20 lying at the seabed 1 and extending outwards to the right-hand side of the figure of drawings.

For connecting the riser 5 to the pipeline 20 there is provided a connecting unit 7 serving for the mechanical joining and the fluid connection between riser 5 and pipeline 20. Besides connecting unit 7 is designed with such a large weight in water that riser 5 is subjected to a desired tensional force during operation of the system. Accordingly riser 5 will assume a generally vertical position in the water. Moreover it is important that the length of riser 5 is so adjusted together with connecting unit 7, that the latter during operation is normally located with its downwardly facing surface 8 at a distance above the seabed 1. Typically there may here be the question of a distance of 15 m at water depths of about 500 m.

The actual connection or joint between unit 7 and riser 5 is indicated at 7A, and shall in principle be a rigid joint, as will be seen more in detail from Fig. 3. The same applies to a rigid connection 7B between the end of pipeline 20 and unit 7. Internally therein there is thus provided a bend, so that the angle between the two rigid connections 7A and 7B will be substantially equal to 90°. It is obvious that this does not have to be an exact right angle, but this can be adjusted somewhat according to the circumstances. However an angle of approximately 90° is preferred, in view

of the installation of the system and possible disassembly, as well as the possibility that connecting unit 7 exceptionally can come into contact with or engagement against the seabed 1. This however is not desired in most of these installations. On the other hand and as already indicated, connecting unit 7 is adapted to rest on the seabed 1 during installation of the system, in particular with a pipeline 20 connected thereto before its being suspended at the lower end of riser 5. In this situation it is an advantage that connecting unit 7 is designed as a base or foundation, with a downwardly facing engagement surface 8 being somewhat extended or enlarged in comparison to the remaining exterior confining surfaces of the unit. The main dimensions of unit 7 are preferably so chosen that the vertical and horisontal dimensions thereof have the same order of magnitude. Thus there is provided a very compact and robust connecting unit 7, having to a high degree the ability to withstand the stress and strain involved during longterm operation of the riser system. The main structure of the unit can be based upon steel and/or concrete.

Riser 5 can consist of a unitary, long tube being transported to an offshore production field in a horisontal position. Then e.g. by ballasting the tube is erected and brought into the vertical position, with subsequence joining to unit 7 which beforehand has been mounted at the end of pipeline 20. Finally the upper end of riser 5 is suspended at platform 10. Another method of installation can comprise the joining of a number of separate tube parts or sections at platform 10 at the same time as the riser 5 being thereby formed, is successively lowered in a manner similar to a drill string, in order to be ultimately connected to unit 7 and pipeline 20 in a similar way as explained above.

Thus a riser system in an L-configuration is formed, as will appear from Fig. 1 and also from Fig. 2. When platform 10 is moving, as discussed in the introduction above, the suspension point 11 at the upper end of riser 5 will undergo displacement, e.g. to the position 11' as shown in Fig. 2. With such an excursion of the suspension point the riser

system itself will also be subjected to an adjustment or change of its configuration, namely by bending in particular at the lower portion thereof, at the same time as connecting unit 7 is elevated. Thereby also pipeline 20 is lifted more from the seabed 1, to an upwardly bended shape as shown at 20'. The region of junction between the two tubes or pipes, i.e. in or at connecting units 7, will however because of the rigid connection as explained above, maintain the mutual, fixed relationship, i.e. with the chosen angle of approximately 90° between the tube connections or portions into unit 7. Accordingly it is the elastic deformation of riser 5 and pipeline 20 as such, that represents the total mobility of the system during the varying conditions or movements, being due to waves, sea currents, wind and other influences.

Fig. 3 shows more in detail the actual connecting unit 7 as well as the introduction of riser 5 and pipeline 10 therein. The riser has an end portion 9A with an increased wall thickness for added stiffness at the joint to the connecting unit. In a corresponding way pipeline 20 has a strengthened end portion 9B for a bending-stiff connection to unit 7. This has an internal bend 23 of 90°. Moreover there is shown an upwardly facing funnel 25 for facilitating the landing of the lower riser end on unit 7.

The stiffened end portions 9A and 9B with increased wall thickness can also have a stepwise increased wall thickness in several steps or a gradually increasing thickness in the direction towards the end to be entered into connecting unit 7. Also other forms of bend-stiffening can be of interest.

In contrast to what is shown in Fig. 1, the bottom surface 8 in Fig. 3 has not been specifically enlarged in order to obtain a larger surface of engagement.

In the case of surface installations or platforms operating with many risers, the solution according to the invention can also be of great value. Such an embodiment is illustrated schematically in Fig. 4, at the upper part of which there is indicated a crown or circumference 33 be-

longing to the rotating member (turret) with which the platform concerned will be equiped. From crown 33 in this case there are suspended a number of risers 35A, 35B, 35C...35E..., 35H, the lower ends of which are connected to respective connecting units 37A-H, being all incorporated in or provided on a frame 30. This frame 30, being here shown as circular, corresponds to the shape of crown 33, but also other fundamental shapes that are preferably closed or regular, can be contemplated. Extending generally in radial direction from the various connecting units there are then provided pipelines 40A, 40B, 40C, 40D...40H. In such embodiment the frame 30 with its connecting units will substantially as a common unit undergo similar movements as illustrated in Fig. 2. However it is possible that the deflection pattern or configuration of pairs of associated risers and pipelines, can vary around the circumference depending upon the instantaneous movement picture.

The relatively rigid risers being discussed above with reference to the figures of drawings, are preferably manufactured of metal, such as steel or titanium, but it can also be possible to employ modern composite materials, which give the desired degree of stiffness seen in view of the tube dimensions. The manner of increasing the bending stiffness as shown in Fig. 3, can be in other forms than the varying wall thickness of the tubes or pipes, as will be obvious to a person skilled in the art.

# Claims

1. Riser system for connecting a floating surface installation (10) to a pipeline (20) at the seabed (1), and comprising

a relatively rigid and generally vertical riser (5), the lower end of which during operation is adapted to be normally located at a distance above the seabed (1), and is connected to a connecting unit,

characterized in

that the connecting unit (7) constitutes a unitary, rigid structure in itself,

that the connecting unit at one hand is rigidly connected (7A) to the lower end of the riser (5) and at the other hand is rigidly connected (7B) to the end of the pipeline (20), and

that the angle between the first and the second rigid connection (7A/7B) to the connecting unit (7) is substantially equal to 90°.

2. Riser system according to claim 1, characterized in that the connecting unit (7) is designed as a base or foundation adapted to rest on the seabed (1) with the pipeline (20) connected thereto before the riser (5) is connected.

3. Riser system according to claim 1 or 2, characterized in that the connecting unit (7) has a sufficient weight in water for applying a desired tension in the riser (5) during normal operation.

4. Riser system according to claim 1, 2 or 3, characterized in that the connecting unit (7) has vertical and horisontal dimensions being generally of the same order of magnitude.

5. Riser system according to claim 2, 3 or 4, c h a r a c t e r i z e d i n that the connecting unit (7) is designed with a somewhat enlarged, downwardly facing surface of engagement (8) for cooperation with the seabed (1), in particular during installation and disassembly.

6. Riser system according to any one of claims 1-5, c h a r a c t e r i z e d i n that there is provided bending stiffening (9A,9B) at portions of the riser (5) and/or the pipeline (20) adjacent to the connection (7A and 7B respectively) to the connecting unit (7).

7. Riser system according to claim 6, c h a r a c t e r i z e d i n that said bending stiffening (9A,9B) is in the form of an increased wall thickness in the riser (5) and/or the pipeline (20) at said portions and in a direction towards the connecting unit (7).

8. Riser system according to any one of claims 1-7, whereby a number of risers (35A-H) and a number of pipelines (40A-H) are incorporated, c h a r a c t e r i z e d i n that a corresponding number of connecting units (37A-H) are provided at or as a frame (30), having preferably a closed or regular fundamental shape.

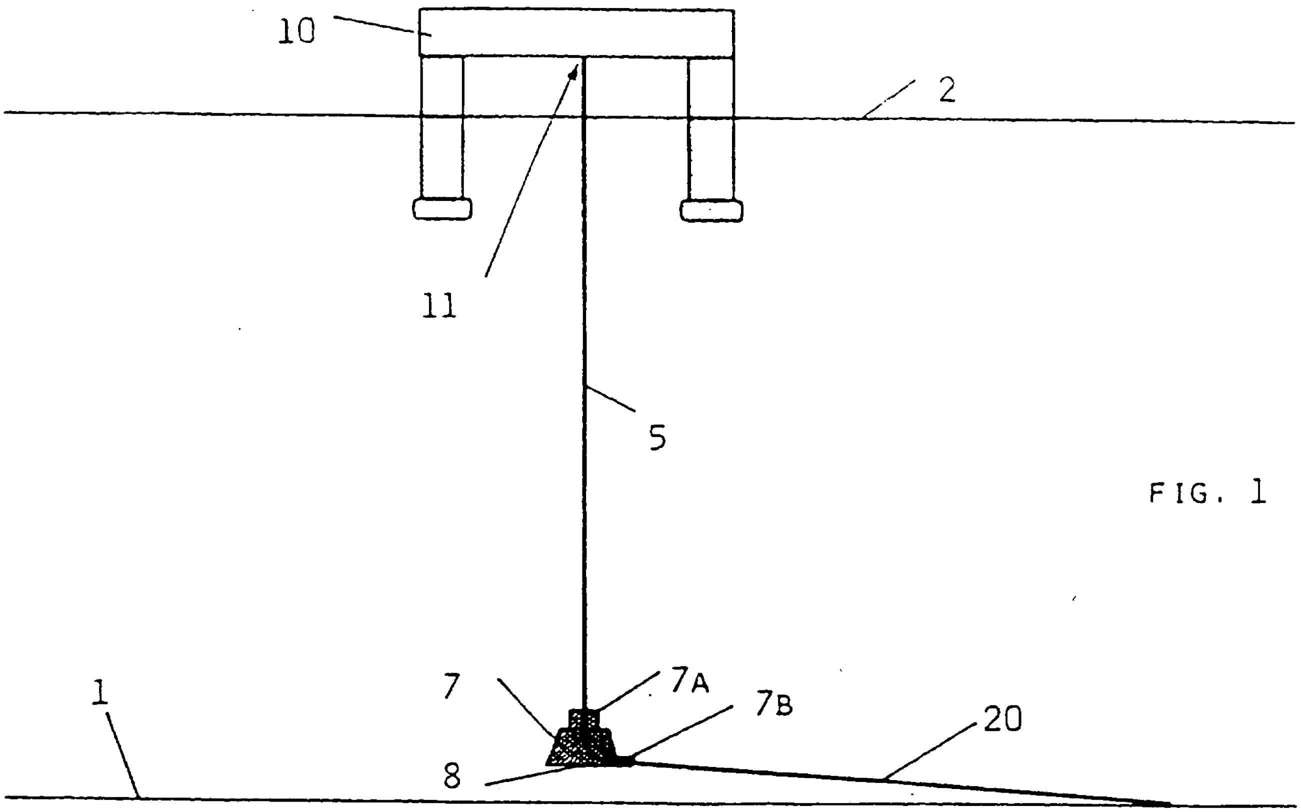


FIG. 1

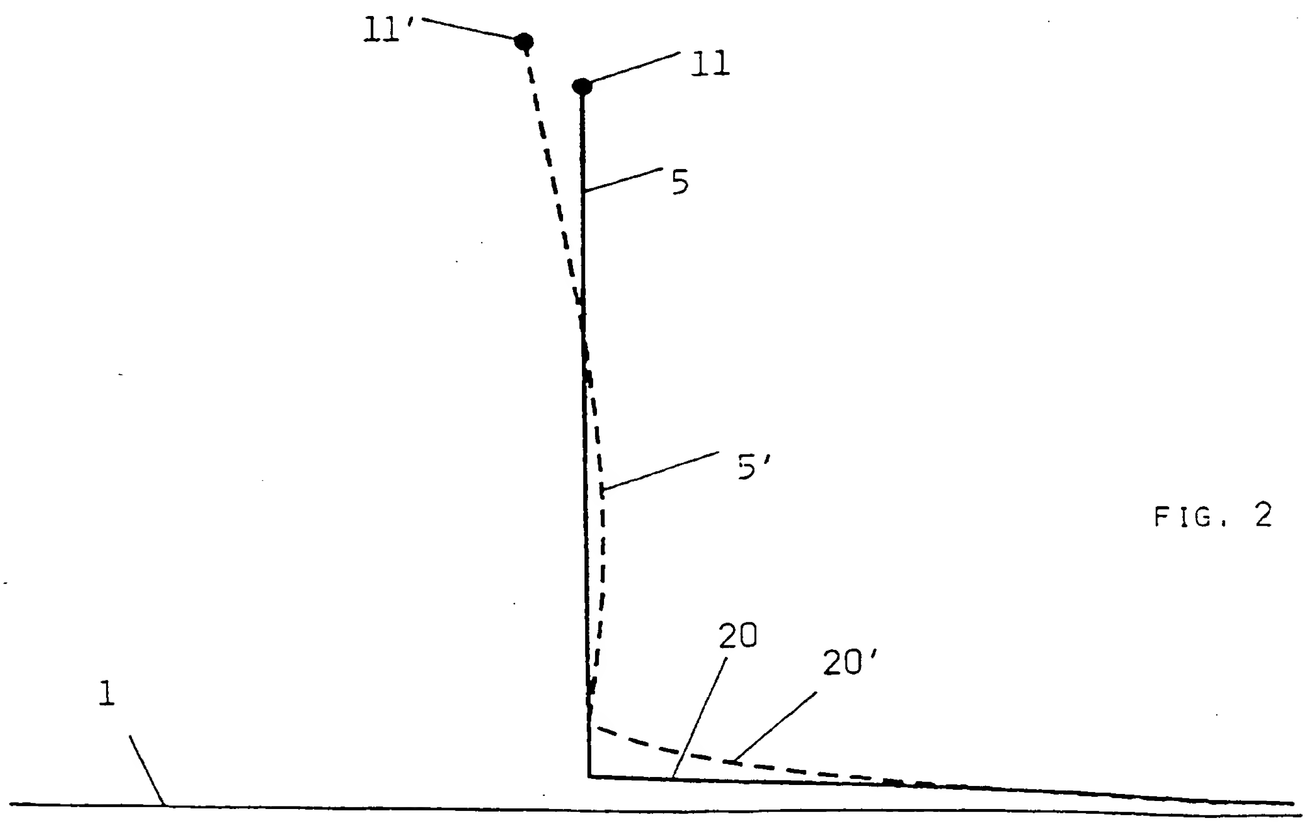


FIG. 2

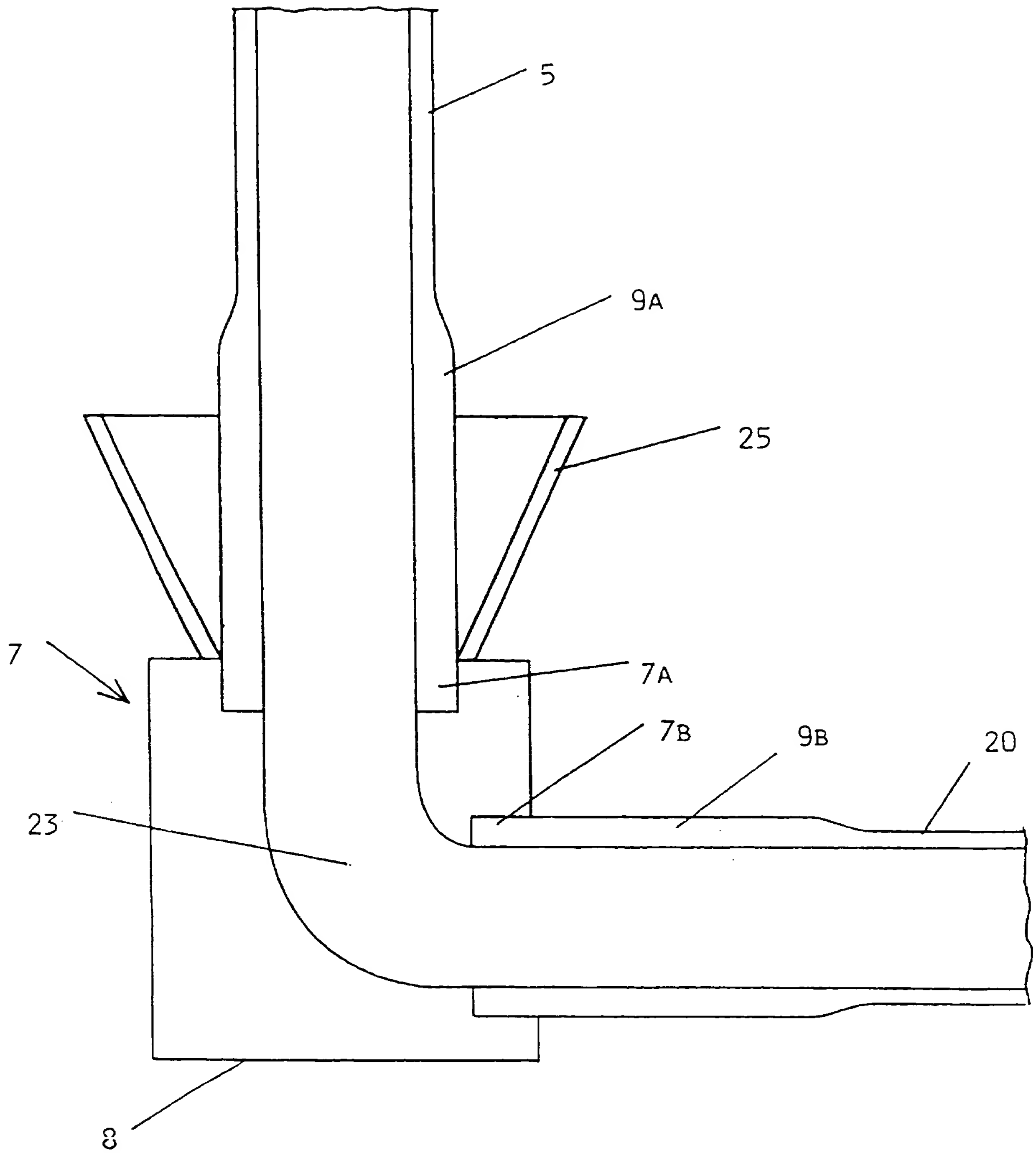


FIG. 3

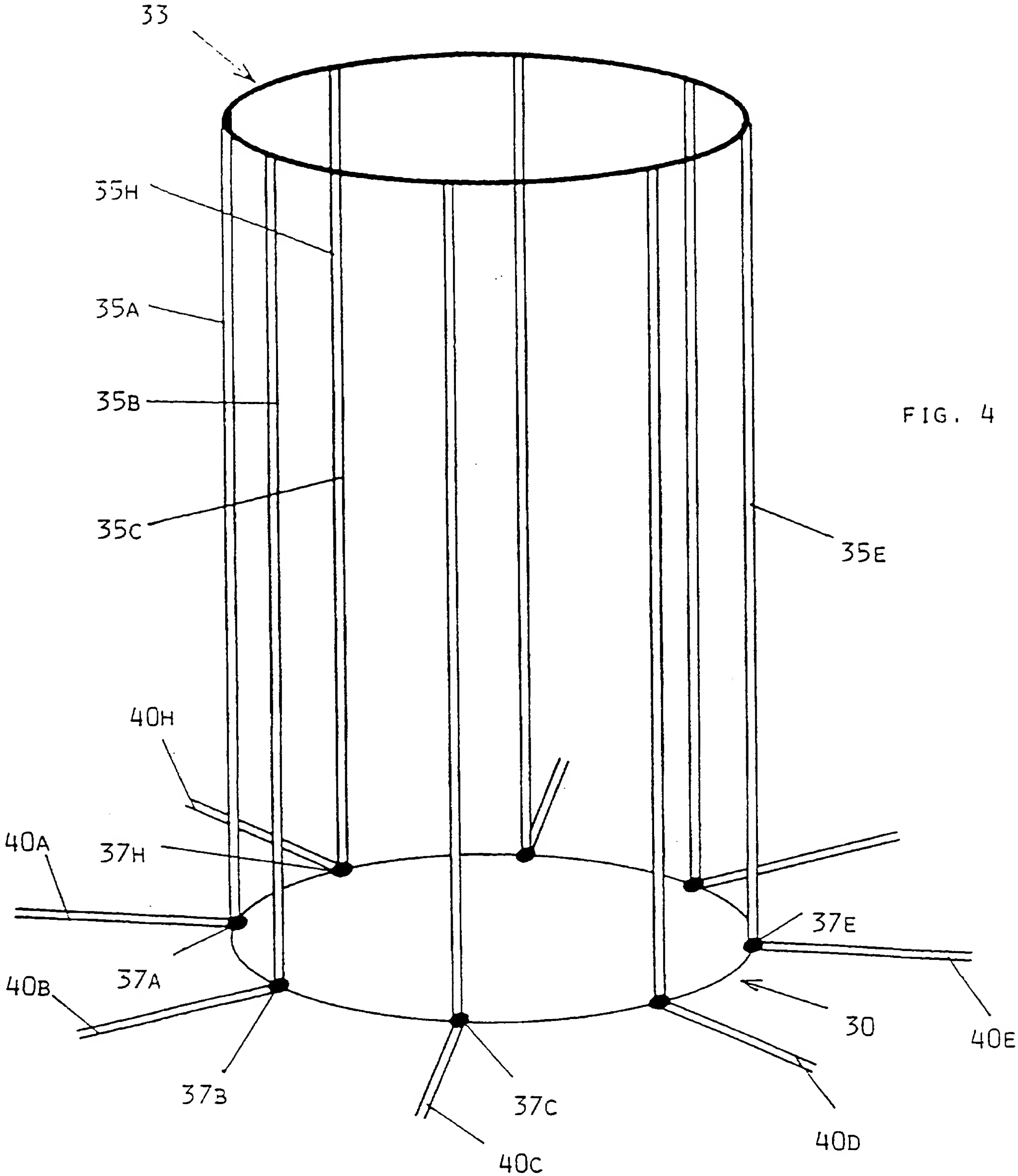
33
35H
35A
35B
35C
35E
40H
40A
37H
37A
40B
37B
37C
40C
40D
30
37E
40E

FIG. 4

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 96/00262

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E21B 17/01
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## B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | GB 2065197 A (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.), 24 June 1981 (24.06.81), page 2, line 107 - page 3, line 60, figure 2<br>-- | 1-8 |
| A | NO 155673 B (DEN NORSKE STATS OLJESELSKAP A.S.), 26 January 1987 (26.01.87)<br>-- | 1-8 |
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[X] Further documents are listed in the continuation of Box C.  [X] See patent family annex.

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# INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| GB-A- 2065197 | 24/06/81 | US-A- 4363567 | 14/12/82 |
| NO-B- 155673 | 26/01/87 | NONE | |
| NO-B- 170233 | 15/06/92 | NONE | |
| NO-B- 152599 | 15/07/85 | NONE | |
| NO-B- 153801 | 17/02/86 | NONE | |